

The Potential of the Internet of Things in Products and Services Development for Older Adults

*El potencial de la Internet de las cosas en productos y
Desarrollo de servicios para adultos mayores*

*O potencial da Internet das coisas em produtos e
Desenvolvimento de Serviços para adultos mais velhos*

Carolina Sallati
Klaus Schützer

ABSTRACT: The aging process is becoming a reality worldwide. This process affects society in many levels, including the development of new products, services and healthcare solutions. Initiatives such as the Active and Assisted Living Programme in Europe develop state of the art research and solutions to address age-related issues and serve as example to countries like Brazil, which experience an accelerated aging process and need to develop age-related solutions at an even faster rhythm.

Keywords: Design; Product Development; Healthcare.

RESUMEN: *El proceso de envejecimiento se está convirtiendo en una realidad a nivel mundial. Este proceso afecta a la sociedad en muchos niveles, incluido el desarrollo de nuevos productos, servicios y soluciones de atención médica. Iniciativas como el Programa de Vida Activa y Asistida en Europa desarrollan investigaciones y soluciones de vanguardia para abordar problemas relacionados con la edad y sirven como ejemplo para países como Brasil, que experimentan un proceso de envejecimiento acelerado y necesitan desarrollar soluciones relacionadas con la edad a nivel global. Ritmo aún más rápido.*

Palabras clave: *Diseño; Desarrollo de productos; Cuidado de la salud.*

RESUMO: *O processo de envelhecimento está se tornando uma realidade em todo o mundo. Este processo afeta a sociedade em muitos níveis, incluindo o desenvolvimento de novos produtos, serviços e soluções de saúde. Iniciativas como o Programa Viver Ativo e Assistido na Europa desenvolvem pesquisas e soluções de ponta para abordar questões relacionadas à idade e servem como exemplo para países como o Brasil, que experimentam um processo acelerado de envelhecimento e precisam desenvolver soluções relacionadas à idade em um nível mais avançado e em ritmo ainda mais rápido.*

Palavras-chave: *Design; Desenvolvimento de Produto; Cuidados de saúde.*

Introduction

It is well known the world is aging. Documented evidence such as the report on aging and health published by the World Health Organization in 2015, and other local reports, such as the World Bank report on aging in Brazil and the European Commission report on demographic aging, point to a direction in which there is no escaping from the population aging process (The World Bank, 2011; European Commission, 2006; WHO, 2015).

People are living longer and better in most cases, but the extension of their lifespan brings along impacts that need addressing in many levels of society, for instance, adapting work places to new needs, understanding new consumer behaviors and demands, providing new solutions in the health area (European Commission, 2006; Glass, 2014). Ultimately, this represents new market niches and business opportunities for industries.

In that matter, initiatives as the Active and Assisted Living Programme (AAL Programme), derived from innovation and development strategies in Europe, develop state of the art research and solutions to address age-related issues, in order to promote an active and connected aging process for older adults present in member-countries of the program. Along with new information and communication technologies-based solutions, the program presents insights on new development and design processes as well. For countries undergoing the aging process at an accelerated rate, like Brazil (The World Bank, 2011), their acquired knowledge is of utmost value.

Therefore, considering: the global population aging process, new market and business opportunities, and the development and integration of new information and communication technologies (ICTs) such as the Internet of Things (IoT), this paper aims to present the AAL Programme and their state of the art solutions in product and services development for older

adults. Furthermore, address the difficulties faced by the AAL Programme in implementing the solutions and provide insight on how countries like Brazil can learn from overseas experiences in product development and services design for older adults.

Literature Review

In this section, Product Development, Product-service Systems, and Information and Communication Technologies, specifically the Internet of Things, are briefly reviewed in order to able further comparative discussion concerning product and services development for older adults.

Product Development

Product development is a process that can be understood from four different perspectives: marketing (Tatikonda, *et al.*, 2001); organizations (Brown, *et al.*, 1995); engineering design (Pahl, *et al.*, 1996); and operations management (Tatikonda, *et al.*, 2001; Krishnan, *et al.*, 2001). Whatever perspective is adopted for research purposes in academia, none of them is solely enough for industrial practice. In a broad approach, Krishnan and Ulrich (Krishnan, *et al.*, 2001) define product development as “the transformation of a market opportunity and a set of assumptions about product technology into a product available for sale”. What these authors call “a market opportunity” can be understood as a need or demand proposed by a consumer group. The “set of assumptions about product technology” refers to feasibility aspects such as technological restrictions and possibilities. “Available for sale” means the product was successfully produced and is now ready for purchase.

The product development process is mainly an industrial activity, having once been considered a determinant factor in competitiveness and strategic management. Industries’ product portfolios were indicative of success in the market, and those who could not keep the pace of developing new products would eventually fall behind (Brown, *et al.*, 1995). It is still important to keep an updated portfolio, considering technological advances and consumption trends oscillation on a daily basis in the market. Nevertheless, just developing new products is not enough. Consumption trends are being influenced by the change in consumer profiles' and needs, creating new market niches and the necessity to improve development and design processes, may they be for products, services, or both (Beuren, *et al.*, 2013).

Product-service Systems

The term product-service system has been used to describe an evolution in meeting consumer demands. First mentioned in 1999 (Goedkoop, et al., 1999), it is defined as a combination of products and services in a system that fulfills user needs through the providing of a functionality. This combination can be divided into three types of product-service systems (PSSs) (Beuren, et al., 2013; Baines, et al., 2007): product-oriented; use-oriented; and result-oriented. Although not new to the market, PSSs still encounter barriers for implementation, especially in the cultural sphere, given different stakeholders demands and increase in companies' responsibilities over products (Baines, et al., 2007).

On the other hand, PSSs can leverage competitive advantage for companies in terms of business strategy. The reason is that PSSs aggregate value to consumers, because of the flexible way in which products and services can be combined to suit customers' needs. The range of combinations possible allows companies to extend market share and reach more customers, thus extending profitability as well. In terms of innovation, PSSs are also more flexible in receiving and offering new products and services combinations, particularly in the ICT field, enabling new business models. In short, competitive advantage for companies that choose to offer PSSs will rest in how they develop a PSS culture in their stakeholders, may they be customers or investors, and how they use innovation resources in the "digital era" (Rouse, et al., 2017).

Information and Communication Technologies: Internet of Things

There is not a universal definition of information and communication technologies but it is widely accepted that ICTs are enablers of modern computing. They refer to the devices, network components, systems, and applications that allow people and organizations to interact in the digital world (Rouse, et al., 2017).

The Internet, as an ICT, enables communication and interaction between people and organizations along with a new range of possibilities for activities of daily life. Over the years, the Internet expanded its framework through devices, machines, and applications, forming a pervasive computing environment in an interconnected ecosystem (Chen, 2012). Such phenomenon brought smart objects that interact with the users and begin to interact with

each other in the pervasive environment, connecting in real time both the physical and digital world. This extended connexion is the Internet of Things.

The term has been around for some time. Today, considering the pervasive environments' perspective, and according to Lee, *et al.* (2013), IoT can be described as “a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on both existing and evolving interoperable ICTs. Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst maintaining the required privacy”. Thus, assuming this definition, IoT can be a useful resource for the creation and development of new products and services, which could assess different needs for different consumer groups, for instance older adults.

The AAI Programme

Origins

The AAL acronym stands for two versions of a research and development joint program derived from different European Union (EU) initiatives designed to address economic, social and technological development on a large scale: Ambient and Assisted Living when it was launched in 2008, and Active and Assisted Living when it was renewed in 2014 to date (AAL Programme, 2016; Commission of the European Communities, 2005; Commission of the European Communities, 2010; European Commission, 2012; European Commission, 2010; European Committee of the Regions, 2005; European Parliament, 2000; European Union, 2014; European Union, 2008). The goal of the program is to address population aging challenges through providing of legal and organizational frameworks for cooperation across the EU member states, covering applied research and innovation development in the field of ICTs for aging well in an already aging society (European Union, 2008). The program also aims to involve medium-sized enterprises (SMEs) in its activities in order to achieve two main strategic objectives: strengthening the scientific and technological base of the European industry and encouraging international competitiveness (European Union, 2008; European Commission, 2007). To achieve such goals, the program should support the development of cost-effective solutions that ensure fair and simplified access to ICT-based products and services to older adults.

In addition, promote innovation in the private sector from co-financing partnerships in market-oriented projects, particularly in SMEs, and implement the technologies and solutions developed in those projects accordingly to the needs of older adults (European Union, 2014; European Union, 2008).

Over almost a decade of existence, the Active and Assisted Living Programme has funded nearly 200 projects through annual calls, which can be verified on the program's website (<http://www.aal-europe.eu/>). It is not the purpose of this paper to discuss all 200 projects, but to address the most recent and relevant solutions from the perspective of state of the art innovation in services design and product development for older adults. Hence, a few selected projects will be discussed ahead.

Projects

In this section, three of AAL Programme's projects will be presented. They were selected considering the availability of information regarding development methodologies; innovation aspects concerning product-service systems; and possible contributions from IoT.

2PCS – Personal Protection and Caring System

This product-service solution was designed to address the loss of mobility older adults suffer. It combines a watch-like device embedded with software features and sensing technologies with a call center service at the user's disposal. The solution offers different functionalities and services that can be personalized by the user, including assistance to outdoor navigation, help on emergency situations, personal assistance at home, or integration with formal care institutions through individually adaptable safety functionalities that can connect to already existing functions, such as automatic fall detection (i.e, 2PCS, 2016; AAL Programme, 2016). For more info, please see <http://2pcs.eu/>.

The development process of the solution followed EQUID-Design guidelines, a product and service design process that certifies Ergonomic Quality In Design from the users' perspective across the entire development process of new products or services (International Ergonomics Association, 2008). It also combined the Kano Model for Customer Satisfaction (Sauerwein, *et al.*, 1996) and QFD (Loos, *et al.*, 2014) in an integrative user-centered process, to assure customer needs would be met and transformed into a feasible product, as illustrated in Figure 1.

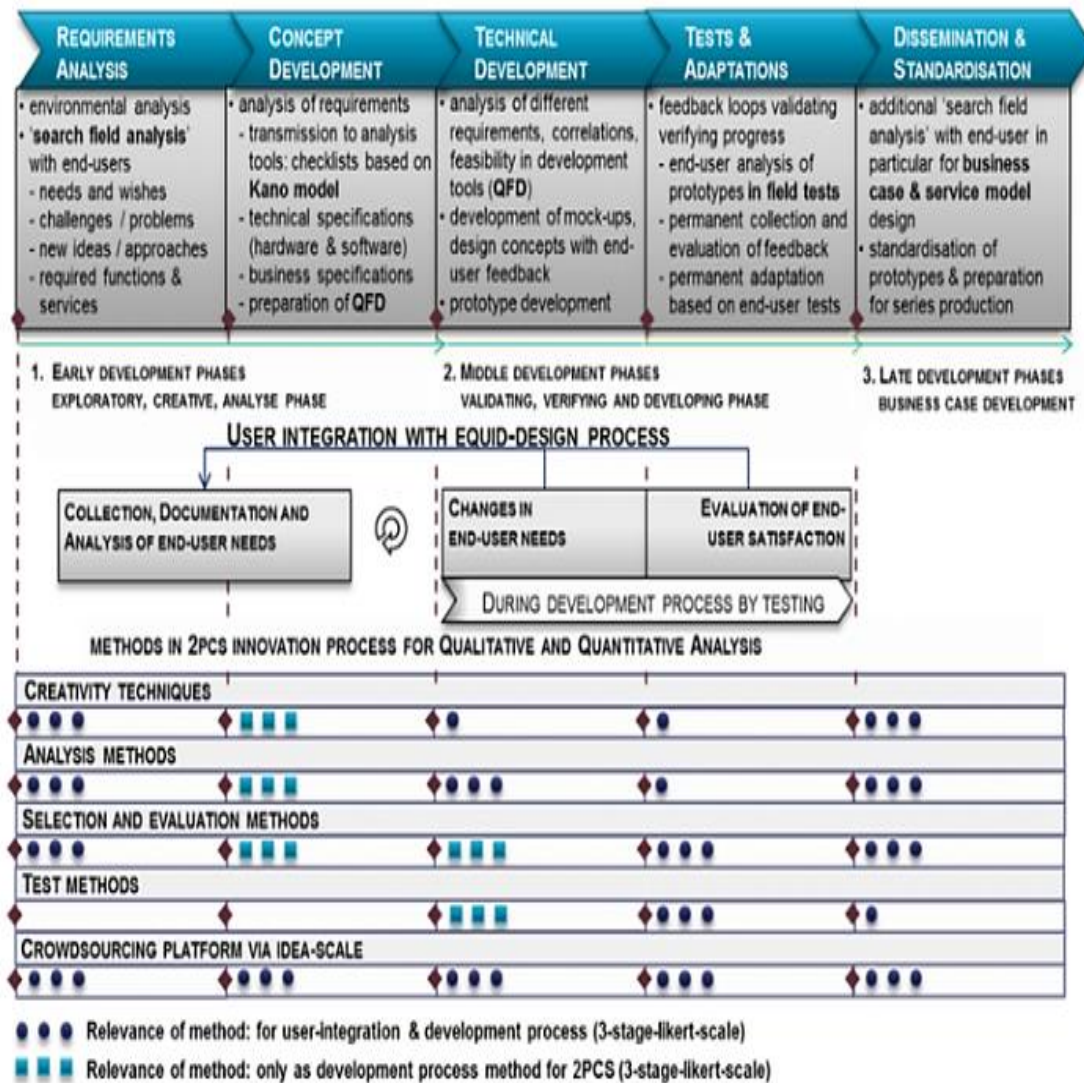


Fig. 1. Source: <http://2pcs.eu/2pcs>

SmartBEAT – Smart system for the management of Heart Failure in older adults

The system is a solution designed to aid older adult patients that suffer from chronic heart failure and their caregivers monitoring health conditions. The solution consists of four main components: mobile vital signs sensing component integrated into a Holter or smart t-shirt for health status monitoring (telemonitoring kit); a smartphone app linked to the telemonitoring kit functioning as a data analyzer; an intelligence component, the Inference Unit, responsible for storing and processing the data obtained from the telemonitoring kit. The inference unit's engine compares the analyzed user's vital signs data with historical data and triggers an alert in case of change.

In addition, it contains a medication knowledge module able to provide personalized information and reminders regarding medication prescription (support applications). The last module is a web application serving as the front-end for formal and informal caregivers and other health professionals, each with different data access permissions (Caregiver Portal) (AAL Programme, 2016; SmartBEAT, 2016). For more info, please see <https://www.smartbeatproject.org/>.

SmartBEAT's development process methodology has at its core the User-Centered Design (UCD) Strategy that proposes user involvement in all phases of the development process, considering that for each product or service different requirements from different stakeholders must be met. Two design approaches were combined to suit the UCD Strategy-based development process: the Contextmapping Method, used to collect a deeper level of information about users' knowledge, feelings, and expectations (Visser, *et al.*, 2005); and the Vision in Product (ViP) design approach that focuses on user-product interaction, targeting desirable rather than strictly feasible possibilities (AAL Programme, 2015; Caicedo, 2008; Lloyd, *et al.*, 2006).

GREAT – Get Ready for Activity Persuasive Ambiences

One of the most recent AAL projects presents a solution focused on assisting older people with dementia in their daily life activities through modulating their environment. The system is based on a learning cloud architecture that integrates motion sensor data and non-intrusive physiological measurements on emotional state, mood and behavior to modulate light, sound, and scent in order to create an ambiance that prepares the person for a determined activity, like having dinner or going to sleep. The system's interface allows the user to manually define time spans, when the modules should be activated, or automatically calculate the time spans from the duration of an action, following the conceptions of learning feedback control system (AAL Programme, 2016; User Centered Technologies Research, 2017). To provide high interoperability, the system combines peer-to-peer network with server-based network to form a portable and compatible network architecture; allows integration with current bus systems and different communication technologies; addresses hardware heterogeneity; implements multi-layered modular software architecture, guaranteeing configuration, scaling and servicing effectiveness; and uses an open interface allowing personalized application for the system (AAL Programme, 2016; User Centered Technologies Research, 2017).

For more info, please see <http://great.labs.fhv.at/>. Like the other projects, GREAT's development methodology is strongly user-centered, utilizing a modular design approach that focuses on delivering high usability and flexibility (User Centered Technologies Research - Vorarlberg University of Applied Sciences, 2017).

Difficulties

In 2010, an interim evaluation proved the AAL Programme had achieved positive results, considering its objectives and the two-year lifespan at the time (Kuneva, *et al.*, 2010).

Such good progress caused the program to be continued in 2014 and set to last until 2020 (European Union, 2014). Nevertheless, the evaluation indicated improvement points that should be assessed in terms of short, medium and long-term addressing, different stakeholders involved and strategy orientation (vision, market, services, impact, and performance). The evaluation report assessed and made recommendations regarding international integration performance, operational performance, financial contributions level, European added value, innovation-based ICT-solutions, critical mass of research and development (R&D), and conditions for industrial exploitation (Kuneva, *et al.*, 2010).

To the purpose of the present work, the most important recommendations concern innovation-based ICT-solutions, critical mass of R&D, and conditions for industrial exploitation. For innovation-based ICT-solutions, the evaluation panel recommended that the focus on technology developed in real life situations should increase and aim at broadly targeted solutions that were usable by carers and intermediaries as well as end-users. For the critical mass of R&D, the recommendations pointed at improving the involvement of end-users, carers, and providers, including the non-profit sector; and focusing on innovative collaboration and further assessment of the European R&D community. Regarding conditions for industrial exploitation, the panel recommended investigating how projects could be more sustainable; reinforcing downstream work in projects and broadening the focus towards practical deployment; defining and targeting beneficiaries; and examining the pattern of reimbursement scheme differences across countries (Kuneva, *et al.*, 2010).

In 2013, at the end of AAL Programme's first edition, a final evaluation report was elaborated restating the good progress of the program towards its objectives and previous recommendations. However, several of the recommendations issues for the three areas mentioned remained, posing as challenges to be overcome.

In the innovation-based ICT-solutions area, the need to focus on wider service and social innovations, not only on a technology niche prevailed. For the critical mass of R&D, sustainability of research and of products and services developed by the program as well as closer involvement of end-users needed further addressing. Regarding conditions for industrial exploitation, reinforcing market orientation across the program, addressing market barriers more explicitly and developing business models and planning were the main issues. As a new recommendation topic concerning all three areas, improving the internal knowledge base on project achievements and insights is needed (European Commission, 2013).

During 2016 AAL Forum, these difficulties were discussed from a different perspective. The program's projects have become more market-oriented; the need to closer involve end-users has been somehow addressed; new business models have been created, serving as innovation platforms when it comes to assisting active and healthy living. Still, market uptake by end-users is not as good as it could be. The challenge to make solutions attractive to the end-users remains (AAL Programme, 2016).

Discussion

Considering the evolution of the ICT field, its logic to think that IoT will soon be an important part of every solution designed, especially in programs like AAL. Thus, it is also possible to assume that from now on, more projects will use IoT as a resource, not only in their methodological development processes but also as an embedded feature, may they be products alone or product-service systems.

In the case of AAL projects, IoT would be a valuable asset in terms of delivering results and making the development process more dynamic. Considering connectivity between devices, product lifecycle management, and availability of technological resources for end-users in Europe, as well as cost of the solutions, the contributions IoT could establish in the discussed projects are not far from realizing. For countries like Brazil, however, several aspects should be taken into account. First, the differences between Brazilian and European older adults' populations. Although older adults are living longer and better overall, and their purchase power has increased (The World Bank, 2011; WHO, 2015), low income is still a reality for a significant portion of them, who live on a minimum salary offered by governmental policies (The World Bank, 2011).

Lower educational levels, also present in a reasonable part of Brazilian older adults, have been associated with lower cognitive functions and lower income, influencing the acquisition and usage of technological resources (Machado, *et al.*, 2015). Moreover, Internet provision is scarce in some parts of the territory (Jansen, 2014). Second, home automation for health solutions, one of the principles behind the AAL projects is still very expensive in Brazil, and not affordable in a great number of cases. Despite these conditions, older adults' income rates and consumption patterns are changing (Araujo, Casotti, Silva, & Pessôa, 2015), along with their demands for products, services, and technologies, creating new market niches that remain underexplored. These consumption patterns and demands are likely to change even more in the future, broadening business opportunities in the technologies, especially ICTs field. However, combining ICTs, or IoT specifically, to products and services solutions for older adults is not guaranteeing they will accept these solutions. The AAL program has been facing this challenge regard of their innovative solutions and integrative development processes.

As it seems, user-centered strategies and methods such as UCD, Contextmapping and ViP, applied to traditional development methods such as QFD and the Kano Model do not result in a successful match between user demand and product or service delivery. Although these methods involve the user in many, if not all phases of the development process, market uptake is still negatively affected. According to A.S. Parent, an important representative of older adults and of the AGE Platform Europe, this deficit in market uptake by the older adults population occurs because “products, services, and solutions are being developed like any other products, services, and solutions in the ICT sector, without considering how older people will react to them” (AAL Programme, 2016). Her speech in the 2016 AAL Forum stressed that older adults currently feel technology is being imposed on them, and not designed to assist or empower them (AAL Programme, 2016). These difficulties pose as lessons for Brazil, given Europe's experience and efforts in aligning population aging impacts to economic and technological development concerns over the last decade and recent years (AAL Programme, 2016; Commission of the European Communities, 2005; Commission of the European Communities, 2010; European Commission, 2012; European Commission, 2010; European Committee of the Regions, 2005; European Parliament, 2000; European Union, 2014; European Union, 2008).

Considering the many differences between Brazil and Europe, the key to achieving successful products and services development processes may lie in the creation of a method that combines user-centered design strategies and consistent development methods with IoT,

in an accessible and systematic manner (Pahl, *et al.*, 1996). From the healthcare and technological advancement perspective, aiming at new feasible business models, as well as from the users' perspective of their needs.

This method should consider specific characteristics of the older adults population, their needs and expectations towards products and services, and utilize traditional development methods as in (Pahl, *et al.*, 1996) and (Rozenfeld, 2006) as foundation to IoT insertion in the process along with the “servitization” trend (Beuren, *et al.*, 2013; Goedkoop, *et al.*, 1999; Baines, *et al.*, 2007).

In order to develop such method, in Brazil's case, for instance, first it is important to understand what type of data is being generated by the older adults population, considering devices and solutions already used by them. The data could provide insights for new demands and development opportunities of new products and services. In addition, provide information of improvement points for available solutions, which would be a significant advantage also for programs like AAL. The combination of the collected data with IoT as a communication network could be part of different stages in the development process, especially in early phases. Users, that should remain involved in the process, could assess the importance of the information gathered, resulting in better acceptance of the products and services developed. Moreover, IoT would serve as a feedback resource to the process, combining data from the early development stages to data from production and later phases of the process. Such a method calls for a deep understanding of not only users and their demands, but of the required structure for IoT implementation in a product and service development process.

Exploring these possibilities in combining already existent product and service development methods with ICTs, especially IoT, is an open field for development and innovation. It may result in contributions that could help fill in the current gaps in market uptake by the older adults population as well as answering to difficulties in absorbing and responding to their demands. In addition, to successfully create such method PSSs must be considered as a delivery approach, due to their integrative characteristics and flexibility. Regarding IoT as a delivery feature, PSSs may be a promising start point for insertion.

Conclusions

In this paper the European Union's Active and Assisted Living Programme was presented, and three of its projects discussed.

Focus was given to the projects' development methodologies, for they represent a shift in addressing population aging issues in a systematic manner. Developing ICT-based solutions for older adults is not just about addressing healthcare and innovation demands but also at promoting development for SMEs and creating an inclusive ICT-based society, as the ICT field advances. In that aspect, IoT can serve as a powerful asset in the development of new products and designing of new services, improving not only the use phase of such products and services, but the entire lifecycle as well.

Furthermore, this work tries to provide insights for Brazil on how to develop new products and services for older adults from AAL Programme's experiences and difficulties. Further research is required to understand specific characteristics and demands of the older adults population, in order to provide for a method that allies IoT to the development of products and services. To the creation of such method, the authors will dedicate further research.

Finally, the authors consider that new business models may come as consequence of new development and design methods, which may lie in between the borders of technological advancement, economic growth, and healthcare assessments.

Acknowledgements

The authors thank CAPES for the financial support.

Referências

2PCS PERSONAL PROTECTION & CARING SYSTEM 2PCS [Online] // 2PCS., 2016, 17 de novembro de 2017, <http://2pcs.eu/2pcs>.

AAL Programme AAL Deliverables: SmartBEAT. Report on UCD Strategy [Relatório] / Active and Assisted Living Programme, 2015, p. 42.

AAL Programme AAL Forum 2016: Executive Summary [Relatório]. - Saint Gallen: [s.n.], 2016, p. 56.

AAL Programme Active and Assisted Living Programme: About [Online] // Active and Assisted Living Programme, 2016, 15 de maio de 2017, <http://www.aal-europe.eu/about/>.

AAL Programme Our Projects: 2PCS [Online] // Active and Assisted Living Programme, 2016, 17 de novembro de 2017, <http://www.aal-europe.eu/projects/2pcs/>.

AAL Programme Our Projects: GREAT [Online] // Active and Assisted Living. - 2016. - 17 de novembro de 2017, <http://www.aal-europe.eu/projects/great/>.

AAL Programme Our Projects: SmartBEAT [Online] // Active and Assisted Living Programme, 2016, 17 de novembro de 2017, <http://www.aal-europe.eu/projects/smartbeat/>.

Araujo, F. F. de., Casotti, L. M., Silva, R. C. M. da, & Pessoa, L. A. G. de P. (2015). O consumidor da terceira idade na primeira década do século XXI: uma análise da propaganda dirigida a idosos. *Revista Administração em Diálogo*, 17(1), 54-85. Recuperado em 30 dezembro, 2017, de: <file:///C:/Users/Dados/Downloads/15098-62242-2-PB.pdf>.

Baines T. S. [et al.] State-of-the-art in product-service systems [Artigo] // *Journal of Engineering Manufacture*. - 2007. - 10 : Vol. 221. - pp. 1543-1552.

Beuren F. H., Ferreira M. G. G. e Miguel P. A. C. Product-service systems: a literature review on integrated products and services [Artigo] // *Journal of Cleaner Production*. - 2013. - Vol. 47. - pp. 222-231.

Brown S. L. e Eisenhardt K. M. Product development: Past research, present findings, and future directions [Artigo] // *Academy of Management Review*. - 1995. - 2 : Vol. 20. - pp. 343-378.

Caicedo David Güiza Vision in Product Design (The ViP approach) [Online] // *Blue Hair*. - 2008. - Dezembro de 2017. - <http://www.bluehair.co/2008/10/vision-in-product-design-the-vip-approach/>.

Chen Y. K. Challenges and opportunities of Internet of Things [Conferência] // 17th Asia and South Pacific Design Automation Conference (ASP-DAC). - [s.l.] : IEEE, 2012. - pp. 383-388.

Commission of the European Communities A Digital Agenda for Europe [Relatório]. - Brussels : [s.n.], 2010. - p. 42.

Commission of the European Communities i2010 - A European Information Society for growth and employment [Relatório]. - Brussels : [s.n.], 2005. - p. 12.

European Commission EUROPE 2020: A strategy for smart, sustainable and inclusive growth [Relatório]. - Brussels : [s.n.], 2010. - p. 35.

European Commission Final Evaluation of the Ambient Assisted Living Joint Programme [Relatório]. - 2013. - p. 44.

European Commission FP7 in Brief: How to get involved in the EU 7th Framework Programme for Research [Relatório] / Office for Official Publications of the European Communities. - Luxembourg : [s.n.], 2007. - p. 32.

European Commission Taking forward the Strategic Implementation Plan of the European Innovation Partnership on Active and Healthy Ageing [Relatório]. - Brussels : [s.n.], 2012. - p. 16.

European Commission The demographic future of Europe - from challenge to opportunity [Relatório] / Office for Official Publications of the European Communities. - Luxembourg : [s.n.], 2006. - p. 17.

European Committee of the Regions The Lisbon Strategy in short [Online] // Europe 2020 Monitoring Platform. - 2005. - 31 de Outubro de 2017. - <https://portal.cor.europa.eu/europe2020/Profiles/Pages/TheLisbonStrategyinshort.aspx>.

European Parliament Lisbon European Council: Presidency Conclusions [Online] // European Parliament. - 2000. - 31 de Outubro de 2017. - http://www.europarl.europa.eu/summits/lis1_en.htm#1.

European Union Decision N° 742/2008/EC of the European Parliament and of the Council on the Community's participation in a research and development programme undertaken by

several Member States aimed at enhancing the quality of life of older people through the use of ne [Relatório] / Official Journal of the European Union L 201. - 2008. - pp. 49-57.

European Union Decision N°554/2014/EU of the European Parliament and of the Council on the participation of the Union in the Active and Assisted Living Research and Development Programme [Relatório] / Official Journal of the European Union L 169. - 2014. - pp. 14-26.

Glass Anne P. Innovative Seniors Housing and Care Models: What we can learn from the Netherlands [Artigo] // Seniors Housing & Care Journal. - 2014. - p. 74.

Goedkoop Mark J. [et al.] Product Service Systems, Ecological and Economic Basics [Relatório] / Report for Dutch Ministries of Environment (VROM) and Economic Affairs (EZ). - 1999. - p. 132.

International Ergonomics Association EQUID Design Process Guidelines [Relatório] / Technical Committee. - 2008. - p. 11.

Jansen Thiago Centro IGLU: Material Áureo [Online] // Centro IGLU - Instituto de Gestão e Liderança Universitária da UFSC. - 2014. - Dezembro de 2017. - <http://iglu.paginas.ufsc.br/files/2014/08/Material-Aureo-2.pdf>.

Krishnan V. e Ulrich K. T. Product Development Decisions: a review of the literature [Artigo] // Management Science . - 2001. - 1 : Vol. 47.

Kuneva Meglena [et al.] Interim Evaluation of the Ambient Assisted Living Joint Programme - Unlocking innovation in ageing well [Relatório] / Independent Panel Report. - 2010. - p. 77.

Lee Gyu Myoung [et al.] Internet of Things [Seção do Livro] // *Evolution of Telecommunication Services* / ed. Bertin Emmanuel, Crespi Noel e Magedanz Thomas. - Berlin : Springer-Verlag, 2013.

Lloyd Peter, Hekkert Paul e van Dijk Matthijs *Vision in Product Design (ViP): the warm bath* [Livro]. - 2006. - p. 15.

Loos M. J. e Miguel P. A. C. Utilização do QFD no desenvolvimento de novos produtos: uma análise das publicações nacionais [Artigo] // Produto & Produção. - 2014. - 3 : Vol. 15. - pp. 17-31.

Machado A. e Vieira M. C. U. Impacto de fatores socioeconômicos na funcionalidade da pessoa idosa portadora de condições crônicas [Artigo] // Revista de Enfermagem da UFSC. - 2015. - 1 : Vol. 5. - pp. 81-91.

Pahl G. e Beitz W. *Engineering Design: a systematic approach* [Livro]. - London : Springer, 1996. - 2ª : p. 574.

Rouse M. e Pratt M. K. Definition: ICT (information and communication technology, or technologies) [Online] // SearchCIO. - 2017. - 20 de Novembro de 2017. - <http://searchcio.techtarget.com/definition/ICT-information-and-communications-technology-or-technologies>.

Rozenfeld Henrique *Gestão de Desenvolvimento de Produtos: uma referência para a melhoria do processo* [Livro]. - [s.l.] : Saraiva, 2006. - 1ª.

Sauerwein Elmar [et al.] The Kano Model: How to Delight Your Customers [Conferência] // International Working Seminar on Production Economics. - Austria : [s.n.], 1996. - pp. 313-327.

SmartBEAT SmartBEAT: The Project [Online] // SmartBEAT: An AAL Project. - 2016. - 17 de Novembro de 2017. - <https://www.smartbeatproject.org/---the-project->.

Tatikonda M. V. e Montoya-Weiss M. M. Integrating operations and marketing perspectives of product innovation: The influence of organizational process factors and capabilities on development performance [Artigo] // *Management Science*. - 2001. - 1 : Vol. 47. - pp. 151-172.

The World Bank Envelhecendo em um Brasil mais velho: implicações do envelhecimento populacional para o crescimento econômico, a redução da pobreza, as finanças públicas e a prestação de serviços. [Relatório] / The World Bank. - Washington : [s.n.], 2011. - p. 62.

User Centered Technologies Research - Vorarlberg University of Applied Sciences GREAT Persuasive Ambiences: Press/Publications [Online] // GREAT Persuasive Ambiences. - 2017. - 24 de Novembro de 2017. - <http://uct-web.labs.fhv.at/presspublications.html>.

User Centered Technologies Research - Vorarlberg University of Applied Sciences GREAT Persuasive Ambiences: Solution [Online] // GREAT Persuasive Ambiences. - 2017. - Novembro de 2017. - <http://uct-web.labs.fhv.at/solution.html>.

Visser F. S. [et al.] Contextmapping: experiences from practice [Artigo] // *CoDesign: International Journal of CoCreation in Design and the Arts*. - 2005. - 2 : Vol. 1. - pp. 119-149.

WHO - World Health Organization World report on aging and health [Relatório]. - 2015. - p. 260.

Recebido em 31/07/2018

Aceito em 30/09/2018

Carolina Sallati - Laboratório de Sistemas Computacionais para Projeto e Manufatura (SCPM), Universidade Metodista de Piracicaba (UNIMEP). Gerontologist, Research assistant and Master student.

E-mail: carolina.sallati@scmp.unimep.br

Klaus Schützer - Prof. Dr. -Ing. - Mechanical Engineer, Professor and Researcher, Laboratório de Sistemas Computacionais para Projeto e Manufatura (SCPM), Universidade Metodista de Piracicaba (UNIMEP).

E-mail: schuetzer@scpm.unimep.br